

Knowledge and Attitude of Health Sciences Students towards Cognitive Enhancers: A Cross-Sectional Study in Jeddah, Saudi Arabia

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ABSTRACT

Cognitive enhancers (CEs) have been emphasized by the growing interest in CEs among university students, which raised concerns about safety, ethical standards, and the accuracy of information about them. However, Saudi Arabian experience about CEs is scarce, particularly in academics. The aim of the current study was to investigate the knowledge and attitudes of the university students in Jeddah, Saudi Arabia toward CEs. University students conducted a validated self-administered online questionnaire within the framework of a cross-sectional study. The survey was conducted to evaluate sociodemographic traits, knowledge of CEs, and attitudes toward CEs. Statistical methods utilizing SPSS version 22 was conducted. The relationships between knowledge level and demographic variables were evaluated using descriptive statistics as well as relevant inferential analyses; a result of $p < 0.05$ was considered statistically significant. Participants' mean age was 20.72 ± 2.43 years, and women comprised 76.6% of the sample. In total, 62.9% of participants fully defined cognitive enhancers, and 65.7% of respondents had prior knowledge of them. Large gaps were found in identifying negative effects and risk perceptions, even though most participants recognized potential cognitive benefits. Attitudes toward CEs were mixed; though a majority noted the potential side effects, fewer participants recognized the risk of addiction, and many perceived potential benefits for cognitive capacity including improved focus and memory. Knowledge was significantly related to academic programs and the year of study ($p < 0.05$), with no association was found to be significant for age or sex. In summary, university students in Jeddah have moderate knowledge of and ambivalent attitudes toward cognitive enhancers, which leads to significant underestimation of the dangers associated with them. These results indicate the importance of focused educational education to raise awareness and facilitate empirically based decision-making regarding the implementation of cognitive enhancers.

Keywords: Cognitive enhancers; Neuroenhancement; University students; Knowledge; Attitudes; Saudi Arabia; Cross-sectional study

INTRODUCTION

The growing use of pharmacological cognitive enhancers (CEs) has gained public health and academic interest among college students¹. Cognitive enhancers were first developed for those who have neuropsychiatric disorders characterized by cognitive decline including attention-deficit/hyperactivity disorder (ADHD) and narcolepsy². They have spread beyond pharmacogenicity, over years, they are termed as nootropics, and are said to increase memory, concentration, alertness and general cognitive efficiency for the healthy. Other users report seeing enhanced attention, inhibitory, and processing speed enhancing

their non-medical use in academic settings^{3,4}. Cognitive enhancement is defined in general: the improvement or extension of core mental capabilities by the enhancement of internal and external information processing systems⁵. University students' substance use for cognitive enhancement is usually driven by academic pressure and improvement in scholastic performance⁶.

A systematic review covering 48 international studies found prevalent use of prescription and non-prescription CEs in healthy students⁷. Common prescription agents are described as methylphenidate,

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modafinil, and piracetam, and nonprescription agents are caffeine, guarana, cobalamin (vitamin B12), pyridoxine (vitamin B6), and vinpocetine⁷. Of those, methylphenidate is the most misused prescription CE⁸ and caffeine tablets the most frequent non-prescription CE⁹. Despite their popularity, the objectively demonstrated efficacy of these drugs against cognitively intact patients has not been supported, thus, warrants further assessment regarding their effectiveness and long-term safety^{3,10}.

There has been a rise in interest in CE use in academia in the last few decades, first in the United States then in Europe and the Middle East¹¹. It was estimated by a large study in the UK that up to a third of students used prescription CEs without medical authorization¹². In addition, a web-based survey of undergraduate students in the southeastern United States found that 5.4% had utilized CE non-medically in the past 6 months¹³. College students such as medical students seem to be particularly at risk, owing to their intense academic and competitive background¹⁴. In a cross-sectional observational study in Saudi Arabia using medical students in Riyadh medical school, illicit stimulant use (OTS) was found in 2.46% of the sample based on long hours of studying time¹⁵. There has been similar data in the United Arab Emirates, where CE use was recorded by 25.3% of university student's surveyed¹⁶. National data from Saudi Arabia are however scant and further epidemiological investigations are warranted. Recent evidence reveals that placebo effects are more important in mediating perceived cognitive benefits in healthy people than pure pharmacological effects^{17,18}. Subjective gains in tired and focused state are highly influenced by the expectation-effects from the competition; however, objective cognitive processes are not in general maintained¹⁸. Placebo effects may additionally limit perception of side effects and may further promote CE use¹⁸. These results provide additional support in raising doubts as to the cognition effectiveness of nootropics and the need for accurate objective assessment¹⁹.

Problems commonly reported with the use of CEs are sleep disturbances, anxiety, mood changes, and gastrointestinal symptoms, and modest increases in heart rate and blood pressure^{20,21}. Increased exposure at high doses to stimulants can contribute to psychosis, psychiatric hospitalization, substance abuse and cardiovascular problems^{22,23}.

The current study aims to determine several items. First, to assess the students' knowledge and attitude for the use of stimulants as well as the factors including gender, age, year of study, study programs and nationalities are candidate variables/factors associated with CE use among the Jeddah college students. Secondly, achieve a better understanding of the possible adverse consequences of CEs use in various spheres, including academic performance.

MATERIALS AND METHODS

Design and Setting of the Study: An observational study on the college students' college perceptions and awareness of CEs to improve their general well-being. Thus, it was carried out as a cross-sectional survey to determine students in Jeddah's College who knew nothing about them; from the various perceptions we found²⁴. Students in Jeddah at Fakeeh College for Medical Sciences (FCMS) were included in this study, which spanned 6 months in the form of six study duration for development of research questions, questionnaire development, data collection, statistical analysis, data analysis and reporting.

Population and Eligibility of the study: The focus population was the male and female students enrolled in a private college campus in Jeddah which were the subjects of this study during the study. Participants were eligible if they were college students already studying in FCMS,

Jeddah and willing to give positive informed consent. Participants included students in all programs of Fakeeh College for Medical Sciences in Jeddah including Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Science in Nursing (BSN), Bachelor of Science in Medical Laboratory Sciences (MLS), and Doctor of Pharmacy (PharmD), English-speaking participants, 18 years old and above. No exclusion criteria were set.

Calculation of Sample Size and Sampling Technique: The sample size was decided by applying Epi Info™ version 7.2 (Centers for Disease Control and Prevention, Atlanta, GA, USA). According to 95 percent confidence, 5 percent error, and to provide sufficient power from a sample size perspective to test the knowledge and attitude domains, the knowledge and attitude baselines were set as 50%²⁵. Therefore, the calculated sample size was 384 students. Participants were recruited using a non-probability convenience sampling technique. Convenience sampling may limit generalizability, but is usually used in web-based surveys directed toward university students because of accessibility and feasibility²⁶. To enhance the study's generalizability and reliability, the online survey was available for a sufficient period. So, the final recruited participants were 402 health sciences students.

Data Collection Instrument: Data were acquired with a self-administered structured questionnaire that was informed by existing literature on cognitive enhancer knowledge and attitude among college students^{3,16,27,28}. The questionnaire included three sections as follows: 1) Socio-demographic features (age, gender, academic year, type of school and GPA). 2) Knowledge about cognitive enhancers (definition, benefits, side effects, legal status). 3) Attitude towards CE use (benefits, ethical concerns, pressure to academically succeed).

In the questionnaire, cognitive enhancers were defined as those which were used to enhance cognitive performance in healthy people: either prescription substances or the non-prescription kind. The questionnaire underwent content validation by the expertise of clinical pharmacologists and public health professionals. The pilot study assessed: clarity, reliability, and the average time that students took to complete the task. Adjustments were made if needed.

Data Collection Procedure: The information obtained by questionnaire was also converted to the online survey form by Google Forms. The survey link was provided via various social media (WhatsApp, Twitter (X), Telegram, Snapchat) to the students at FCMS in Jeddah. The questionnaire was available only for voluntary completion by participants. The first part of the online questionnaire was an electronic informed consent form. Participants were required to read, and consent to, the informed consent statement prior to answering the questionnaire. For anonymity, no identifying details were collected.

Ethical Considerations and Confidentiality: Ethical approval of the study was carried out by Dr Soliman Fakeeh Hospital Institutional Review Board (DSFH IRB) (FIRB-25-0145). Participation was voluntary and students were informed they could withdraw from the study at any point without ever having to make a justification for doing so and without any consequence. Confidentiality and anonymously collected data were all taken care of through no fault of respondents. The data were stored in a secure password-protected database; the researchers were the only personnel to access this database. Following the ethical guidelines of the Declaration of Helsinki, data analysis was carried out²⁸.

Statistical Analysis: Data were exported from Google Forms to Microsoft Excel and analyzed using the Statistical Package for Social Sciences (SPSS) package version 22 (IBM Corp., Armonk,

NY, USA). The data were described descriptively. The age variable was reported as mean $\pm$ standard deviation (SD) and median and interquartile range. Categorical data were reported as percentages and frequencies. Appropriate tests were applied to assess the normality of distribution of the age variable. Association between age and correct identification of CEs was evaluated by the Mann–Whitney U test. In addition, associations between other categorical variables and correct identification of CEs were assessed using the Chi-square (χ^2) test and Fisher Exact Test. Statistical significance was established at $p < 0.05$.

RESULTS

Table 1 displays the demographic data of the 402 participants. The mean age of the participants was 20.72 ± 2.43 years, ranged from 18 to 40 years. The median age was 20 years. The majority of respondents were female (76.62%). Regarding academic programs, more than half of the participants were enrolled in the MBBS program (60.2%),

followed by Nursing (23.88%) and PharmD (7.96%). Students from Respiratory Care (4.98%) and Medical Laboratory Sciences (2.99%) represented smaller proportions of the sample. With regards to the current year of study of participated students, the largest proportion were first year students (28.36%), followed by second year students (19.40%). Students in Years 3 to 6 each accounted for approximately 10% to 13% of the sample, while interns represented 5.72%.

Table 2 shows the knowledge of participants about CEs, 65.767% of students reported that they have heard about CEs. The most common source of information reported by the students was social media (46.77%), followed by friends (33.33%), then health care workers (22.89%), and the least percentage of students (11.69%) reported that their source of information was Television or radio. Regarding perceptions of the spread of cognitive enhancer use within their community; 36.32% of participants believed that such behavior is common.

Table 1. Demographic data of the participants (n=402)

Demographic data	Subcategory	N	%
Age	Mean $\pm$ SD	20.72 $\pm$ 2.43	
	Median (IQR)	20 (3)	
	Range	18-40	
Gender	Female	308	76.62
	Male	94	23.38
Program	MBBS	242	60.2
	Nursing	96	23.88
	PharmD	32	7.96
	Respiratory care	20	4.98
	MLS	12	2.99
Current Year of Study	Year 1	114	28.36
	Year 2	78	19.4
	Year 3	41	10.2
	Year 4	51	12.69
	Year 5	53	13.18
	Year 6	42	10.45
	Intern	23	5.72

SD: Standard Deviation, IQR: Interquartile range, MLS: Medical laboratory sciences

Table 2. Knowledge about cognitive enhancers among participants (n=402)

Knowledge questions	Subcategory	N	%
Have you ever heard about cognitive enhancers?	Yes	264	65.67
	No	138	34.33
What is the meaning of cognitive enhancers?	Cognitive enhancers are substances that improve mental functions such as memory, attention, and problem-solving skills	253	62.94
	Cognitive enhancers are medications that permanently increase physical strength and endurance.	42	10.45
	Cognitive enhancers are devices used to amplify sound waves for better hearing.	3	0.75
	I don't know	104	25.87
	Social media	188	46.77
What are your sources of information about cognitive enhancers? (participants could apply more than one answer)	Friends	134	33.33
	Health care workers	92	22.89
	Television or radio	47	11.69
	I never heard about it	107	26.62
	No	85	21.14
	Yes	146	36.32
Is the usage of cognitive enhancers considered a common behavior in your community?	I don't know	171	42.54

Figure 1 demonstrates that 62.94% correctly identified the meaning of CEs. However, 37.06% of the students did not correctly identify CEs.

Table 3 displays the reported effects of using CEs, regarding benefits from using CEs, the correctly identified benefits of using CEs reported by the participants were improved memory retention and recall (80.60%), increased focus and attention (63.43%), enhanced problem-solving and critical thinking skills (56.72%), faster learning and information processing (50.00%), reduced mental fatigue during prolonged tasks (48.76%) and greater idea generation (29.85%). Regarding side effects of using CEs; the correctly identified side effects reported by the participants were insomnia, increased heart rate or palpitations, anxiety

or nervousness, headaches or migraines, dependence or tolerance over time and digestive issues (35.82%, 30.35%, 28.61%, 25.87%, 19.40%, and 16.17%; respectively)

Table 4 displayed the attitudes of participants regarding CEs; only 255 participants responded to the attitude questions; among them, around 40% agreed that cognitive enhancers can cause addiction. Almost half of the participants agreed that cognitive enhancers can enhance alertness and focus (46.67%) and improve memory and learning (42.75%). In contrast, when asked whether cognitive enhancers can cause side effects, the majority (62.35%) agreed, with only a small minority (4.31%) disagreeing.

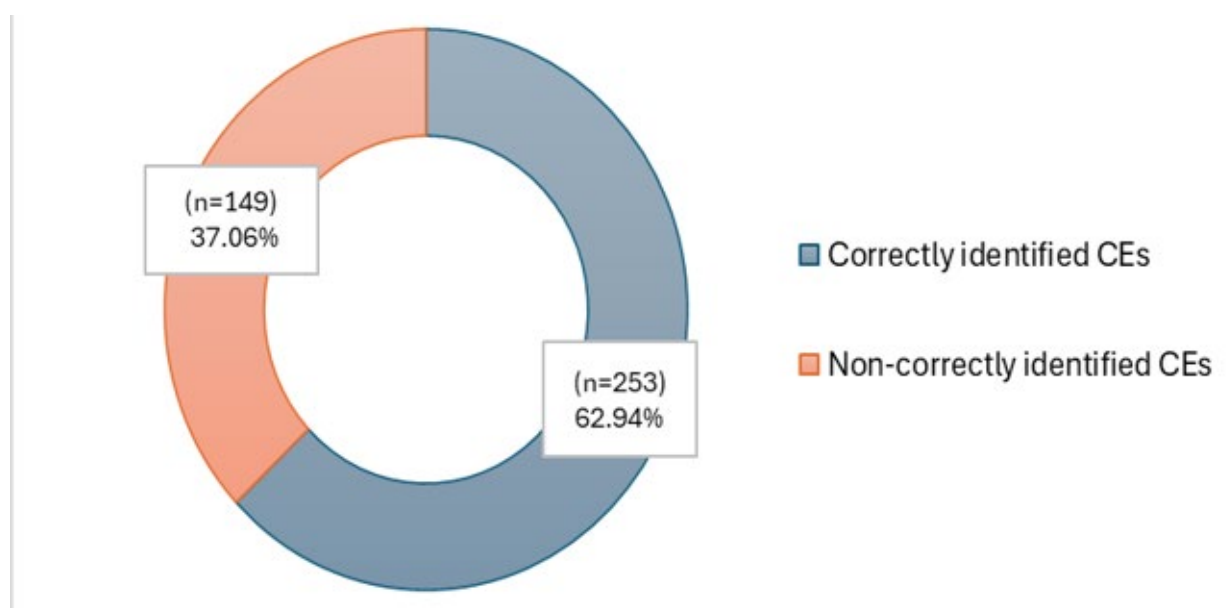


Figure 1. Distribution of students who correctly identified cognitive enhancers among participants (n=402)

Table 3. Knowledge about the effects of cognitive enhancers among participants (n=402)

Effect of CEs questions	Subcategory	N	%
What are the benefits of cognitive enhancers? (participants could apply more than one answer)	Improved memory retention and recall	324	80.60
	Increased focus and attention span	255	63.43
	Increased physical strength and muscle growth	87	21.64
	Reduced mental fatigue during prolonged tasks	196	48.76
	Permanent cure for all neurological diseases	49	12.19
	Enhanced problem-solving and critical thinking skills	228	56.72
	Faster learning and information processing	201	50.00
	Instant weight loss without diet or exercise		
	Greater idea generation	120	29.85
	Improved eyesight and night vision.	21	5.22
	I don't know	200	49.75
What are the side effects of cognitive enhancers? (participants could apply more than one answer)	Insomnia or difficulty sleeping	144	35.82
	Headaches or migraines	104	25.87
	Increased heart rate or palpitations	122	30.35
	Bone marrow suppression	42	10.45
	Permanent hair loss	52	12.94
	Anxiety or nervousness	115	28.61
	Dependence or tolerance over time	78	19.40
	Digestive issues like nausea or stomach upset	65	16.17
	Sudden loss of vision	27	6.72
	I don't know	161	40.05

Table 4. Attitude towards cognitive enhancers (n=255)

Attitude questions	Disagree		Neutral		Agree	
	N	%	N	%	N	%
In your opinion, do cognitive enhancers cause addiction?	34	13.33	118	46.27	103	40.39
In your opinion, do you feel that cognitive enhancers can increase your alertness and focus?	17	6.67	119	46.67	119	46.67
In your opinion, do you feel that cognitive enhancers can improve memory and learning?	32	12.55	114	44.71	109	42.75
In your opinion, do you feel that cognitive enhancers can cause side effects?	11	4.31	85	33.33	159	62.35

Table 5. Association between participants' demographic characteristics and correct identification of cognitive enhancers (n = 402)

Demographic data	Subcategory	Correctly identified cognitive enhancers (n=402)				p value
		Yes (n=253)		No (n=149)		
		N		N		
Age	Mean ± SD	20.90	2.59	20.41	2.10	0.092 ^a
Gender	Male	63	67.02	31	32.98	0.349 ^b
	Female	190	61.69	118	38.31	
Program	MBBS	169	69.83	73	30.17	0.001 ^{*c}
	Nursing	53	55.21	43	44.79	
	PharmD	20	62.50	12	37.5	
	MLS	5	41.67	7	58.33	
	Respiratory care	6	30	14	70	
Current Year of Study	Year 1	63	55.26	51	44.74	0.01 ^{*b}
	Year 2	50	64.1	28	35.9	
	Year 3	24	58.54	17	41.46	
	Year 4	26	50.98	25	49.02	
	Year 5	39	73.58	14	26.42	
	Year 6	31	73.81	11	26.19	
	Intern	20	86.96	3	13.04	

SD: Standard Deviation, MLS: Medical laboratory sciences, ^a: Mann-Whitney U-Test, ^b: Chi-Square Test, ^c: Fisher Exact Test, *: Statistically significant when the p-value is <0.05.

Table 5 demonstrates the association between participants' demographic characteristics and their ability to correctly identify CEs. It shows a statistically significant association between the academic program and correct identification of CEs ($p = 0.001$). Students enrolled in MBBS and PharmD programs showed higher proportions of correct identification compared to those in Nursing, MLS, and particularly Respiratory Care, where the lowest proportion was observed. Similarly, the current year of study was significantly associated with correct identification of CEs ($p = 0.01$). It shows that 55.26% of year 1 students, 64.1% of year 2 students, 58.54% of year 3 students, and 50.98% of year 4 students correctly identified CEs. However, in years 5 and 6, approximately three-quarters of students correctly identified cognitive enhancers (73.58% and 73.81%, respectively). The highest level of correct identification is seen among interns (86.96%). Regarding other demographic factors, table 5 shows that age and gender were not considered significant factors affecting the correct identification of CEs.

DISCUSSION

In the current cross-sectional study, the knowledge and attitudes of university students of Jeddah region of Saudi Arabia towards cognitive enhancers (CEs) were investigated, aiming to discover the knowledge and attitudes of campus students on these substances in terms of academic demands. The results highlighted that approximately two-thirds of subjects were familiar with cognitive enhancers and that 62.9% of them correctly identified their definition. This suggests moderate knowledge, but a significant number of students' understanding was not accurate, due to underlying knowledge gaps.

Such a level of awareness is in line with studies performed on university students in the Middle East and Europe^{2,7,28}. But when it occurred, awareness sometimes failed to match understanding, especially when it came to adverse impacts and side effects. There is a knowledge gap as a significant part of participants could not accurately identify negative consequences. This disparity in knowledge exposes the commonality of CEs, yet the knowledge is partial and in limited depth.

Healthcare professionals, where social media and peer networks were the main knowledge sources, were listed as supplementary sources of knowledge. The results are in agreement with similar findings of prior studies^{6,2,28} that cast doubt on the validity of students accessing the data. Dependency on informal information could lead to misperceptions, inflated benefits, and undervaluing dangers. These findings highlight the potentiality of structured training programs which are provided by universities and healthcare professionals.

Regarding effect knowledge, the majority were correct in characterizing some of the cognitive benefits that they observed, including enhanced memory and concentration. Misconceptions remained however, whereby students erroneously assumed CEs provided unrealistic or impractical benefits. What is more, the level of side effect awareness was comparatively poor and a significant negative impact of side effects (e.g. dependence, cardiovascular consequences, and sleep problems) was not well known and few of the participants appeared to appreciate the potential adverse effects of CEs. These results in accordance with research that students tend to overestimate benefits and underestimate threats^{3,10}.

We discovered a variety of attitudes towards cognitive enhancers. Although most respondents were aware of the potentially harmful effects of CEs, few believed that CEs had been associated with addiction. But a larger percentage of students believed cognitive benefits including better concentration and memory, might be possible. This mixed perspective, which is vulnerable to both good and bad side effects, has been found in the literature and seems to be a reflection of the ambivalent character of neuroenhancement^{1,5}.

There is disagreement which implies that students must consider benefits versus drawbacks as opposed to being confused. This finding is consistent with previous research that demonstrated that the risk perception, necessity and ethical consequences, as well as perceived necessity to engage in the use of cognitive enhancers, are involved in decisions related to cognitive enhancement, often more than knowledge^{1,11} as opposed to only knowledge. Importantly, years of study and study program had a great effect on level of knowledge. Cognitive enhancers were more visible for higher academic levels of students, as well as students pursuing medical-oriented coursework. This result is also in line with previous work showing that involvement in education is important for health-concept knowledge^{6,14}. It underscores also the importance of integrating specialized education materials early in the academic curriculum.

Results indicated clearly that institutional interventions are required to better inform students about cognitive enhancers, and cultivate an informed attitude to this topic. And there must be evidence-based education programs within universities about the pharmacological components and potential hazards of CEs, the moral consequences of CE, and the absence of established benefits among healthy respondents. Also, encouraging critically examining news sources, especially social media, is critical to fighting misinformation.

Among the strengths of the present study are a relatively large sample size, which allows for the inclusion of students from different disciplines to present a comprehensive assessment of knowledge and attitudes. Unfortunately, certain limitations need to be mentioned. Convenience sampling has limitation, and self-reported data will likely create a response bias. Second, without making the inference of cause, it cannot be said since the study design is cross-sectional. Additional longitudinal studies evaluating the influence of educational interventions to improve awareness of cognitive enhancers within university students and their attitudes need to be conducted.

CONCLUSION

This study shows that university students in Jeddah have a moderate level of knowledge on cognitive enhancers yet also have mixed and ambivalent attitudes towards its use. But there are still large gaps in information on the risks and adverse effects associated with it that are not currently well documented: the cognitive benefits, however popular they may seem among students today, are poorly understood in terms of knowledge.

Lastly attitude captures a balance of perceived academic benefits against risks to students' safety and ethical implications. The significant association between the academic program and knowledge level highlights the degree to which educational backgrounds impact students' awareness and perceptions. These results indicate a need for targeted educational interventions within academic institutions for improving accurate knowledge, addressing misconceptions to students, and developing informed and responsible attitudes toward cognitive enhancers within the context of education.

Future research should focus on evaluating the effectiveness of educational strategies in improving students' knowledge and shaping more evidence-based attitudes toward cognitive enhancers.

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